OFFICE OF CIVIL ENGINEERING
UNITED STATES COAST GUARD
WASHINGTON, D.C.

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SPECIFICATION FOR 12-VOLT, 110 WATT SOLID STATE FLASHER FOR MARITIME AIDS TO NAVIGATION

SPECIFICATION NO. 481A

1. SCOPE.

1.1 General. This specification establishes the performance and test requirements for 12-volt, direct-current (DC), 110 watt solid-state flashers with linear DC output voltage to the lamp. The flashers are to be used for flashing marine aids to navigation lamps. In addition, the flashers shall regulate output voltage to the lamps, sense burnt-out lamps, control a 12-volt lampchanger as specified herein, and provide daytime/nighttime illumination control (when coupled with a photoresistor) for an aids to navigation beacon.

1.1.1 Additional Information. Flashers are normally intended to flash lamps from DC voltage sources of 11.25 to 16 volts. Power is provided by: (1) air depolarized, primary-batteries; (2) secondary lead-acid batteries; or, (3) transformer-rectified DC power supplies. In normal operational use, flashers will be contained in beacon assemblies on buoys or fixed structures in or around the navigable waters of the United States. Lamps will usually be 12-volt, incandescent, tungsten filament lamps rated from 0.55 to 3.05 amperes, or tungsten-halogen lamps rated at 9.2 amperes (110 watts). The lamps will be mounted in lampchangers conforming to G-SEC Specifications 195 and 478**.** Although the flashers are mounted in a lantern assembly, they will nevertheless be exposed to all the elements of weather, including but not limited to rain, snow, and wind, and on occasion they will be immersed in water. The flashers may also be used to operate other types of aids to navigation equipment with high-input impedances.

1.2 Precedence. Any ambiguity or conflict between this specification, drawings, and/or applicable documents shall be resolved by using the following documents in the precedence shown:

a. The wording of this specification.
b. Drawings contained in or attached to this specification.
c. Applicable documents.

1.3 Government Furnished Equipment (GFE). The following equipment shall be loaned to the contractor for use in first article testing:

(4) CG-6P Lampchanger
(4) WK-681 Wiring Kit
(4) Type "C" Photoresistor
(4) Type "L" Photoresistor
(10) 12-volt, 0.55-ampere Marine Signal Lamps
(10) 12-volt, 3.05-ampere Marine Signal Lamps
(10) 12-volt, 110-watt Marine Signal Lamps

1.4 Definitions. The following definitions shall apply to these terms whenever they appear in this specification.

1.4.1 Flasher, Solid-state. An electrical device with no moving parts that interrupts the power to a light beacon according to a specified time-based characteristic, causing the beacon to flash with

a specified rhythm. A flasher also performs accessory functions as specified herein and defined below.

1.4.2 Rhythm. The time-based characteristic of flashes of light alternating with eclipses of darkness exhibited by a light beacon during one period.

1.4.3 Beacon Assembly, DC-Powered. A beacon assembly consisting of a lantern, a lens, a 12-volt lampchanger (containing one lamp in the "burning position" and at least one spare lamp capable of moving into the burning position when so controlled), and a flasher.

1.4.4 Accessory Functions. There are three accessory functions in the solid-state flasher required by this specification. They are defined as follows:

a. Lamp-out sensor and control. A circuit that senses current to the lamp during the flash and, if the current is less than a specified value, causes the lampchanger to move a spare lamp into the burning position; or switches a transfer relay that transfers the power from the lantern with the burnt-out lamp to a spare lantern with an operable lamp.

b. Illumination control. A circuit such that when a photoresistor conforming to G-SEC Specification 234 is connected to it, stops the flow of current to the lamp if the ambient illumination exceeds a certain value, or permits current to flow to the lamp if the illumination falls below a certain value.

c. Voltage regulator. A circuit that limits the output voltage to a specified range of values.

1.4.5 Self-protection features. There are two self-protection features in the flasher required by this specification. They are defined as follows:

a. Reverse-polarity protection. An electrical circuit that ensures the flasher will not be impaired in any way if the input terminals are connected across a battery in reverse polarity, provided that the battery's open-circuit voltage does not exceed the maximum allowable input voltages specified for the flasher.

b. Short-circuit protection. An electrical circuit that ensures the operation of the flasher will not be impaired in any way if either the "F", "L", or "S" terminals are connected to the case, to the positive or negative power leads, or to each other.

1.4.6 12-volt battery. A secondary, lead-acid battery with a minimum rating of 75 ampere-hours.

1.4.7 Input voltage. The closed circuit voltage (CCIV) observed at the input power terminals when the lamp is radiating at maximum incandescence.

1.4.8 Output Voltage. The closed circuit voltage (CCOV) observed at the "L" and "-" terminals when the lamp is radiating at maximum incandescence.

2. APPLICABLE DOCUMENTS.
The following documents form a part of this specification to the extent specified herein:

2.1 Specifications (Current Revision).

U.S. Coast Guard:

G-SEC 487	12 Volt Marine Signal Lamps
G-SEC 195	12-volt, Six-place Lampchanger for Maritime Aids to Navigation (Type CG-6P)
G-SEC 234	Photoresistors for Solid State Flashers
G-SEC 478	12-volt, 110 watt, Six-Place Lampchanger for Maritime Aids to Navigation (high-watt model)

Other Military Specifications:

MIL-DTL-15024F 28 Nov 1997	Plates, Tags, and Bands for Identification of Equipment, General Specifications of

2.2 Standards.

Military:

MIL-STD-202G 18 Jul 2003	Test Method Standard for Electronic and Electrical Component Parts
MIL-STD-129P 10 Feb 2004	Military Marking for Shipment and Storage
MIL-DTL-31000B 14 Dec 2001	Technical Data Packages
MIL-STD-889B (3) 17 May 1993	Dissimilar Metals

2.3 Drawings.

U.S. Coast Guard Drawing (Current Revision)

EOE 120006	12-Volt, Solid-State Flasher

2.4 Publications.

Bureau of Ships

NAVSHIPS 94501	Bureau of Ships Reliability Design Handbook
Military	(NOTE: Military Handbooks Are listed for information only, NOT as a requirement)
MIL-HDBK-454A 30 Nov 2000	General Guidelines for Electronic Equipment

3. REQUIREMENTS.

3.1 Design and Construction. The flasher shall be of solid state design and construction, and shall be of quality which will ensure compliance with the requirements of this specification. All materials shall be compatible with each other under all conditions encountered in the use of flashers in Coast Guard aids to navigation.

3.2 Environment. Each flasher shall operate as specified under the following environmental conditions:

3.2.1 Ambient Temperature. From -25°F through 140°F.

3.2.2 Humidity. From 0% through 100% relative humidity.

3.2.3 Salt Air and Saltwater. Each flasher shall be constructed of materials so as to be resistant to corrosion from continuous exposure to salt air and immersion in saltwater.

3.2.4 Shock and Vibration. Each flasher shall be constructed to withstand the shock and vibrations incident to service on lighted buoys.

3.3 Physical Requirements.

3.3.1 Size. The dimensions of each flasher case shall conform to those specified in Drawing EOE 120006, attached to this specification.

3.3.2 Mounting Holes and Mounting Surface. Four mounting holes shall be located on the mounting surface as specified in Drawing EOE 120006. The mounting surface shall be two bosses. The dimensions of the bosses shall not exceed those shown on Drawing EOE 120006. The top surfaces shall be co-planar. The mounting holes shall be made of threaded stainless steel, nickel-plated steel, or nickel-plated brass inserts, or equivalent. It shall be possible for a 10-32 screw to enter to a depth of 5/16" or more.

3.3.3 Terminal and Terminal Insulators. There shall be six external, 8-32 wire clamp screw terminals located as specified in Drawing EOE 120006. There shall be clamping pressure plates on each side of the lug, each with a minimum conductive surface area of a 11/32" diameter

circle. The pressure plates, the terminal screws, and the threaded inserts shall be a common conductor to the flasher circuit. All terminals shall be enclosed in slotted insulators sized to accept three, 11/32"-wide spring spade and/or hook lugs for a No. 8 stud. The insulators shall be sized to accept the lugs from the front and the back. The terminals shall be molded of colored dielectric materials in accordance with the color code given in paragraph 3.3.4. With one of the above lugs in place, the top of the terminal screws shall not project above the top of the insulators. Terminal screws shall be long enough so that they do not fall out when inserting three of the above lugs. The top of the insulators shall not extend above the mounting surface, as shown in Drawing EOE 120006. Terminal screws shall be supplied with the flasher. 300 series stainless steel screws in tinned brass terminals shall be provided in the terminal strip.

3.3.4 Terminal Arrangement and Marking. Terminals shall be arranged and permanently labeled as shown in Drawing EOE 120006. Terminal markings may be incorporated in the nameplate. The terminal markings have the following meanings:

Terminal / Color	**Meaning**
"-" White	input terminal for negative battery lead and negative lead to lampchanger via lampchanger's negative terminal.
"+" Black	input terminal for positive battery lead.
"S" Yellow	the two “sun switch” terminals across which the day-light control (G-SEC Specification 234) is connected.
"L" Red	output terminal for positive, regulated, time-coded voltage, to be connected to lamp via lampchanger's lamp terminal.
"F" Blue	output terminal for positive voltage to lampchanger's (CG-6P) actuating mechanism.

3.4 Flasher case. The case shall be of suitable hardness and rigidity, and have low moisture absorption under the humidity and temperature conditions specified herein. The case shall retain its design contours without warping, crazing, cracking, or corroding in service or in storage. The case shall be sealed to ensure the watertight integrity of the encased electronic circuitry. The case may be plastic, metal or a combination of both.

3.4.1 Electrical Isolation. Each flasher terminal shall be electrically isolated from the case by at least 500,000 ohms.

3.5 Materials.

3.5.1 Electronic Components. Solid state components shall be used to accomplish all required electrical/electronic functions. There shall be no moving parts.

3.5.2 Potting. The electronic components shall be embedded in potting material to ensure that they are protected from moisture. The potting shall be of suitable hardness and rigidity, and have low moisture absorption under the humidity and temperature conditions specified herein. The potting shall retain its design contour without warping, crazing, or cracking in service or in storage.

3.5.3 Dissimilar Metals. Materials used shall be galvanically compatible to minimize electrolytic action. Use of dissimilar metals, as defined in MIL-STD-889, shall not be in intimate contact, with the following exceptions:

a. Use of stainless-steel threaded inserts in combination with an aluminum housing, and

b. Use of stainless-steel, nickel-plated steel, or nickel-plated brass screws in tinned brass terminals.

3.6 Workmanship. Workmanship guidelines and recommendations are presented in MIL-HDBK-454.

3.7 Electrical. The flasher shall function as specified in this paragraph when operated within the extremes of the environmental conditions. The output voltage shall be applied to lamps conforming to G-SEC Specification 487.

3.7.1 Input Voltage. The flasher shall be capable of being powered by primary and secondary batteries and transformer-rectified power supplies with less than 3% ripple. Voltage source spikes of 20 Vdc shall not damage the flasher. The flasher shall operate as specified with input voltages (CCIV, 1.4.7) ranging from 11.25 Vdc to 18.0 Vdc (maximum continuous CCIV of 14.0 Vdc for 2.03 A, 3.05 A and 110 watt lamps). The flasher need not perform as specified for CCIV of less than 11.25 Vdc; however, the flasher shall not be damaged by CCIV of less than 11.25 Vdc.

3.7.2 Output Voltage. The flasher shall provide a positive, time coded, regulated output voltage between the "-" and "L" terminals. The closed circuit output voltage (CCOV, 1.4.8) shall be regulated as follows:

CCIV (Volts DC)	CCOV (Volts DC)
11.25 – 12.40	The difference between the input voltage and output voltage may be no greater than 0.25 Volts.
12.41 – 18.00	11.90-12.20

3.7.3 Output Current. The flasher shall flash any 12 Vdc, tungsten filament, marine signal lamp with a current rating of 0.55 A to 9.2 A (110 watts). The lamps shall achieve full incandescence if the applied voltage time exceeds the lamp incandescence time. The flasher shall provide

current to any resistive load that draws 0.25 amperes or greater and 9.2 amperes (110 watts) or less.

3.7.4 Parasitic Current.

3.7.4.1 Daytime. The idling power consumed by the flasher in daytime operation shall not exceed 20 milliamperes.

3.7.4.2 Nighttime. When operating under nighttime conditions (timing circuit enabled), the input power to the flasher and lamp, exclusive of the lamp power, shall not exceed 30 milliamperes. The input current to the flasher and lamp when the lamp is not energized shall not exceed 20 milliamperes.

3.7.4.3 Daytime/Nighttime. As an alternative to paragraph 3.7.4.1 and 3.7.4.2, the sum of the daytime and nighttime input current to the flasher (exclusive of lampchanger current) shall not exceed 40 milliamperes. Lampchanger current shall be zero during daytime and nighttime when the lamp is not energized.

3.7.5 Short-circuit Protection. Each flasher shall have short-circuit protection so that connecting the "L", "F", or "S" terminals to the "+" or "-" terminal, or to the flasher case, or to each other does no harm. The flasher shall resume all normal functions as soon as the short circuit is removed without resetting any device. This short-circuit protection shall function at the same time as the reverse polarity protection.

3.7.6 Reverse-polarity Protection. Each flasher shall have reverse polarity protection on the positive and negative terminals. The flasher shall resume proper operation as soon as the correct polarity is applied. The reverse polarity protection shall function at the same time as the short-circuit protection.

3.7.7 Timing Rhythms. The output voltage at the "L" and "-" flasher terminals shall be time coded as specified below. The voltage shall be applied to the lamp for flash intervals F, and shall not be applied to the lamp during eclipse intervals E. The time coding, or rhythm, is defined by continuous operation of these intervals. The duty cycle for a rhythm is the total lamp-on time (sum of F intervals) divided by the total time of the rhythm (sum of F and E intervals). The period is defined as the total time of the rhythm.

3.7.7.1 Rhythms.

CODE	TIMING SEQUENCE	DUTY CYCLE	NSN
FL6(1)	Fl = 1.00 sec El = 5.00 sec	0.17	5945-01-GL3-5359
FL4(1)	Fl = 1.00 sec El = 3.00 sec	0.25	5945-01-GL3-5358
FL2.5(1)	Fl = 1.00 sec El = 1.50 sec	0.40	5945-01-GL3-5357
Iso2	Fl = 1.00 sec E1 = 1.00 sec	0.50	5945-01-GL7-6171
Iso6	Fl = 3.00 sec El = 3.00 sec	0.50	5945-01-GL3-5356
Oc4	Fl = 3.00 sec El = 1.00 sec	0.75	5945-01-GL3-5355
FIXED	Continuous	1.00	5945-01-GL3-5354

A contractor that is approved to supply flashers with the listed timing rhythms by passing all First Article Tests (FAT) shall also be approved to provide flashers with unique or special timing rhythms.

3.7.7.2 Timing Tolerance. The flash intervals, the eclipse intervals, the period, and the duty cycle shall be within 5% of the specified values.

3.7.8 Lamp-out Sensor and Lampchanger Control. The flasher shall contain circuitry which shall sense a filament failure of the operating lamp and shall actuate any lampchanger conforming to G-SEC Specification 195. If, while flashing, the current drawn from the "L" terminal falls to zero, the flasher shall deliver at the "F" terminal a positive voltage signal between 8.0 and 18.0 volts DC to operate a CG-6P lampchanger conforming to G-SEC Specification 195 until sufficient current is drawn from the "L" terminal. The "F" terminal signal shall be at least one 0.25 to 5.0-second pulse every 10 seconds. Pulses will be at least 0.4 seconds apart. When the lamp-out control is not actuated, the voltage between the "F" and "-" terminals shall not exceed 0.5 volts DC.

3.7.8.1 Spurious Activation Prevention Due to Discontinuities. A single discontinuity of 10 milliseconds or less in the "L" and "-" circuit shall not cause spurious activation of the "F" circuit.

3.7.8.2 Prevention of Damage Due to Inductive Voltage Spikes. The flasher shall not be damaged by voltage spikes induced on the "F" circuit by the lampchanger's stepping mechanism (solenoid coil).

3.7.9 Compatibility With Incandescent Lamps. When powered by a battery that provides input voltage of between 12.4 Vdc and 18 Vdc, the flasher shall not limit the current in-rush so as to

reduce the intensity or shorten the flash length of a 12-Vdc, 0.55 A to 110 watt incandescent lamp. The output voltage shall reach 90% of the steady state value within 20 milliseconds after the voltage is applied. The voltage shall decay to 10% of the steady state value within 10 milliseconds after the applied voltage is removed.

3.8 Illumination Control. The flasher timing, regulating, and lamp-changing circuitry shall be controlled by a photoresistor conforming to G-SEC Specification 234. The photoresistor will be connected at the two yellow "S" terminals. The photoresistor will disable the timing, lamp-changing, and regulating circuitry during daylight hours (to conserve power) and enable this circuitry at night. If the photoresistor is removed from the flasher, all other circuits shall function as specified.

3.8.1 Photoresistors. The illumination control circuitry shall disable the flasher before the photoconductive resistance across the "S" terminals falls below 10,000 ohms. The illumination control circuitry shall enable the flasher before the photoconductive resistance across the "S" terminals exceeds 40,000 ohms. The illumination control circuitry shall bias the external photoresistor no more than 6 Volts such that the photoresistor dissipates no more than 40 mW.

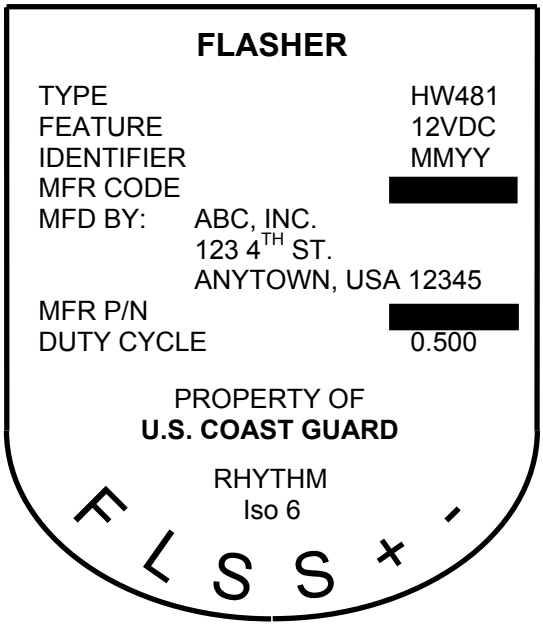
3.8.2 Voltage. The illumination control circuitry shall disable the flasher before the voltage measured at Vab exceeds 8 Vdc (Figure 2). The illumination control circuitry shall enable the flasher before the voltage at Vab falls below 2 Vdc.

3.8.3 Spurious Activation Prevention Due to Illumination Level. With a photoresistor conforming to G-SEC Specification 234 connected between the two "S" terminals and pointed directly at the flashing lamp, the flashing lamp shall not spuriously activate the illumination control circuitry or cause the light to flash on a different rhythm when the ambient illumination level is less than the level at which the flasher is turned on. Spurious activation shall be prevented electronically and shall not depend on the physical shading of the flashing lamp. Consideration of the nigrescence of incandescent lamps (i.e., natural decay of incandescence after removal of electrical power to the lamp) and the response time of daylight control indicates that the illumination-control circuit should be de-energized for a short time after termination of the flash; however, in the "FIXED" flasher, the illumination-control circuitry shall function continuously and the photoresistor will be located out of the line-of-sight of the lamp.

3.8.4 Effect of Ambient Illumination. The illumination control circuitry, in conjunction with a photoresistor conforming to G-SEC Specification 234, shall not cause the flasher to operate on a changed rhythm at any level of ambient illumination below its "turn-off" level.

3.8.5 Effect of Artificial Illumination. The flasher shall not malfunction when tested with a photoresistor conforming to G-SEC Specification 234 under ambient natural daylight, incandescent, or fluorescent lights. The flasher shall perform only as described in paragraphs 3.8 through 3.8.4 for ambient natural daylight, incandescent, and fluorescent light.

3.9 Nameplate. MIL-DTL-15024, TYPE G, or a two mil metallized silver coated polyester nameplate shall be affixed to the top of the flasher. The information required on the nameplate is shown in Figure 1 (next page).



Example of a typical Nameplate (3.9)

Figure 1

The manufacturer shall obtain the manufacturer's code from the Specification Preparing Activity (SPA), which is usually the Ocean Engineering Division, COMDT (G-SEC-2). The identifier field shall be the month and year the flasher is delivered. An example is 1193 for November 1993. (Note: The terminal and rhythm markings have been incorporated into the nameplate in this example.) Use of the entire address on the "MFD BY:" field of the nameplate is optional. Only the contractor's name is required in this field. Additionally, the contractor's name may be at the top of the nameplate.

3.10 Rhythm Marking. The rhythm marking, as specified in 3.7.7.1, shall be permanently affixed to the top of the flasher case in the space indicated in Drawing EOE 120006. The rhythm marking may be incorporated in the nameplate. Type size shall be 3/32" or larger.

3.11 Bench Test Operation. A production flasher that does not perform only as described by this specification is defective. A production flasher shall function as described below for any bench test conditions prior to field installation. Flashers shall:

a. Flash a lamp only at a definite, single, specified rhythm (3.7.7 through 3.7.7.2);

b. Regulate the output voltage (3.7.1 through 3.7.3);

c. Sense a lamp failure (lamp-out sensor) and provide an "F" pulse (3.7.8 through 3.7.8.2); and

d. Have illumination control (3.8 through 3.8.5).

Any other behavior is a malfunction and the flasher is defective.

3.12 Engineering Drawings and Associated Parts Lists. The manufacturer shall develop and maintain engineering drawings and associated parts lists for the FAT flashers in accordance with MIL-DTL-31000, paragraph 3.6.3 (DID Number DI-SESS-81000B). The SPA will inspect and approve the drawings and parts lists. A copy of the approved drawings and parts lists shall be signed and dated by the manufacturer and SPA, and then placed in a sealed envelope, which will be kept at the manufacturer's facility. Production flashers shall strictly conform to the approved, sealed copy of the drawings and parts lists. The SPA may at any time, in the company of the manufacturer, open the envelope for the purpose of reviewing the drawings or parts lists to compare them to actual circuitry and parts used in production flashers.

4. INSPECTION AND ACCEPTANCE.

4.1 Responsibility.

4.1.1 First Article Test Inspection Responsibility. All inspections are the responsibility of the contractor and will be conducted at a facility acceptable to the Government. A test plan shall be submitted to the SPA not later than 30 days prior to the commencement of first article testing. At a minimum this plan shall include:

a. A chronological listing of the tests to be performed.

b. Location of the test facility.

c. A complete listing of all equipment to be used.

d. Detailed test procedures for each test, including wiring diagrams of test setups and pass/fail criteria.

e. All other pertinent information necessary to fully describe the test.

f. Test data sheets shall be provided with the test plan and shall be used to record observed performance data.

Upon completion of the testing, the contractor shall submit to the SPA a test report documenting, at a minimum, test equipment used, last date of calibration of test equipment, and completed test data sheets.

4.1.2 Production Inspection Responsibility. The contractor shall conform to all requirements of the Federal Acquisition Regulations (FAR) Part 52.246-1; Contractor Inspection Requirements, and Part 52.246-2; Inspection of Supplies, Fixed Price.

4.2 First Article Tests (FAT).

4.2.1 Notification. The contractor shall provide the Contracting Officer (KO) a detailed test plan of the FAT. After approval of the FAT plan, the contractor shall notify the KO 15 days prior to the start of testing. A government representative shall monitor the FAT.

4.2.2 Tests Sample and Sequence. Ten flashers shall be submitted for FAT. All ten flashers shall be subjected to the Basic Capabilities tests (4.3). At the conclusion of the Basic Capabilities tests six flashers shall be subjected to the Environmental tests (4.4.1) and four flashers shall be subjected to the Accelerated Life tests (4.4.2). At the conclusion of these tests, all ten flashers shall be subjected to the Electrical Tests (4.4.3). At the conclusion of the Electrical tests, four flashers shall be subjected to the Corrosion Resistance Tests (4.5). Tests shall be performed on all of the flashers regardless of failures. Table I details the FAT requirements.

4.2.3 Flasher Submission. Flashers submitted for FAT shall be representative of the manufacturer's proposed normal production. The first article test sample shall consist of two flashers each of the FL6(1), FL4(1), and FIXED rhythms; and one flasher each of the FL2.5(1), Iso2, Iso6, and Oc4 as defined in 3.7.7.1.

4.2.3.1 Acceptance Level. All flashers submitted for FAT must comply with the acceptance/rejection criteria for the Basic Capabilities Tests (4.3), Environmental Tests (4.4.1), Electrical Tests (4.4.3), and Corrosion Resistance Tests (4.5).

4.3 Basic Capabilities Tests. Flashers shall be subjected to a series of initial tests to verify the basic capabilities of the flasher. Unless otherwise specified, the flashers shall be powered by a DC power supply set at 12.0 ±0.1 volts for the Basic Capabilities Tests.

4.3.1 Visual Inspection. Each flasher shall be visually inspected to see that the terminals and terminal markings are properly placed and legible (3.3.4).

4.3.2 Mechanical Conformation to Specifications and Drawings. Measure the following features to ensure compliance with the specification:

a. Dimensions (3.3.1)

b. Number, location, and depth of screw entrance into mounting holes (3.3.2)

c. Number, thread-type, location, and length of terminal screws (3.3.3)

d. Size of slotted terminal insulators and compatibility with three, 11/32" spade or hook lugs. Sufficient height to insulate terminals with one lug in place. Terminal insulators not to extend above the mounting surfaces (3.3.3).

4.3.3 Conditioning. All flashers will be conditioned by subjecting them to three 24-hour cycles of temperature variation consisting of 16 hours at 140°F (-0°F, +5°F) and 8 hours at -25°F (±5°F). The transitions between 140°F and -25°F shall be accomplished within the 8-hour period so that the time at the high temperature is 16 hours. During the temperature cycling, each flasher shall operate a 110 watt lamp in the 140°F interval and a 0.55-ampere lamp in the other temperature intervals from a 14-volt DC power supply source. Only a 110 watt lampchanger (G-SEC Specification 478) shall be used to operate a 110 watt lamp. 110 watt lamps shall not be used in standard CG-6P lampchangers. A 15 ohm resistor shall be connected between "F" and "-" and the "S" terminals shall be left open.

4.3.4 Electrical Isolation. Connect +18 volts DC between each terminal and one of the lampchanger mounting holes in the case for at least 5 seconds, note the current flow and calculate the resistance. The resistance shall not be less than 500,000 ohms between each terminal and the case (see 3.4.1).

4.3.5 Reverse-polarity and Short-circuit Protection. With a 15 ohm resistor connected between "F" and "-" and a 110 watt lamp between "L" and "-", verify that the flasher complies with 3.7.5 and 3.7.6 by:

a. Making the following connections, one terminal at a time, with normal input polarity and holding for 10 seconds:

1. "L", "F", "S", "S", "+", and "-" to the case

2. "L", "F", "S", and "S" to "+"

3. "L", "F", "S", and "S" to "-"

4. "L" to "F"

5. "S" to "S"

b. Repeat 4.3.5.a with reversed input polarity.

4.3.6 Lamp-out Sensor and Control. With the flasher connected to a lampchanger conforming to G-SEC Specification 195, remove the operating lamp and verify that the flasher activates the lampchanger stepping mechanism to place the next lamp into the operating position (3.7.8). Insure that a momentary discontinuity in the lamp circuit does not activate the "F" circuit with a 0.55 lamp (3.7.8.1).

4.3.7 Resistive Illumination Control. With a photoresistor conforming to G-SEC Specification 234 connected between the two "S" terminals, verify that the illumination-control circuitry will turn the flasher on and off as required in 3.8. With the photoresistor aimed directly at the flashing lamp, verify that the flashing lamp does not spuriously activate the illumination-control circuitry or cause the light to flash on a changed rhythm (3.8.3). Using a variable resistor connected between the "S" terminals, measure the turn on and turn off resistances and verify compliance with the requirements of 3.8.1.

4.3.8 Voltage Illumination Control. With the flasher connected to the solar voltage regulator circuit illustrated in Figure 2, verify that the illumination control circuitry turns the flasher on and off as required in 3.8.2.

4.3.9 Output Voltage and Current. For input voltages of 16.0 (18.0 for 0.55 A lamp), 12.4, and 11.25 volts verify conformance with the requirement for output voltage and output current (3.7.2, 3.7.3) when flashing a 0.55 ampere lamp, a 3.05 ampere lamp, and a 110 watt lamp.

4.3.10 Timing Tolerance. Measure the flash and eclipse lengths of a flasher powering 0.55 and 3.05 ampere lamps, and a 110 watt lamp using a digital timer triggering off the positive and negative slopes of the voltage pulse. Calculate the period and duty cycle to verify compliance with the requirements of 3.7.7.2.

4.3.11 Acceptance/Rejection Criteria. Failure of more than one flasher to comply with all aspects of the Basic Capabilities Tests (4.3) shall constitute failure of the FAT and shall be cause for rejecting the flashers.

4.3.12 Power Terminal Sensitivity. Connect the flasher to a 12 Volt DC power source, a CG-6P lampchanger with lamps, and a photoresistor. Turn on the power source and cover the photoresistor, causing the lamp to display the rhythm specified on the manufacturer's label. Next, mechanically disconnect and reconnect the positive terminal to the power source. Allow two seconds for the flasher circuitry warm-up and then record the rhythm the flasher displays. Flashers displaying a rhythm different from that specified on the manufacturer's label after the two second warm-up period or which cause the lampchanger to ratchet are defective. Disconnect

and reconnect the positive terminal a minimum of ten times per flasher and record the flasher rhythm and lampchanger action as described above.

4.3.12.1 Acceptance/Rejection Criteria. One failure shall be reason to withhold approval of the manufacturer's product.

4.4 Laboratory Tests. After completion of the Basic Capabilities Tests (4.3), the ten flashers submitted for FAT shall be subjected to a series of Laboratory Tests. Six flashers will be subjected to Environmental Tests (4.4.1) and the other four flashers will be subjected to the Accelerated Life Test (4.4.2).

4.4.1 Environmental Tests. Six flashers shall undergo Environmental Tests. All six flashers will be subjected to each test in the order listed below.

4.4.1.1 Vibration. Flashers shall be tested in accordance with MIL-STD-202, Method 204-D, Test Condition 'D', except that amplitude must be maintained at 10G's (not 20G peak) and with duration reduced to three 20-minute cycles in each of three mutually perpendicular axes (x, y, & z) for a total of nine complete cycles (180 minutes total). The flasher shall be rigidly attached to a fixture capable of transmitting all of the vibration conditions.

4.4.1.2 Shock. Flashers shall be shock tested in accordance with MIL-STD-202, Method 213-B. Flashers shall be rigidly mounted prior to testing. Shocks shall be applied in only one direction for each of three mutually perpendicular axes (x, y, & z). A total of ten shock pulses of 11 milliseconds duration, 40G peak acceleration, sawtooth waveshape shall be applied to each flasher: three along one axis, three along another axis, and four along the final axis. The axis that receives four blows (instead of three) is chosen at random for each flasher. Use Test Condition 'G' reduced from 50G's to 40G's.

4.4.1.3 Immersion. Flashers shall be completely immersed in tap water at 68 ± 18ºF for 2 hours. The flashers shall be immersed so that the uppermost portion of the case is six inches below the surface of the water. Air dry and inspect the exterior for separation of parts, dissolving of compounds, adhesives, or other deterioration which could cause the flasher to fail.

4.4.1.4 Environmental Test Evaluation. At the conclusion of the Environmental Tests, subject all six flashers to the Electrical Isolation Test (4.3.4).

4.4.1.5 Acceptance/Rejection Criteria. Two flashers with an isolation between the lampchanger mounting holes and any terminal of less than 500,000 ohms at the conclusion of the Environmental Tests shall constitute a failure of the whole test procedure and shall be reason for rejecting the flashers.

4.4.2 Accelerated Life Test. The four flashers not subjected to the Environmental Tests (4.4.1) shall be subjected to two Accelerated Life Tests. Accelerated Life Test number 1 shall consist of operating the four flashers at 140°F (-0°F, +5°F) and ambient relative humidity for a period of 360 hours (15 complete days). The flashers, with a photoresistor conforming to G-SEC

Specification 234, and 15 ohm "F" circuit load resistor, shall be cycled as follows while operating a 110 watt lamp and powered by a 12-volt power supply.

The test procedure is as follows:

a. In a darkened test chamber, with an input voltage of 14.0 volts DC, operate the flasher for 120 hours;

b. Decrease the input voltage to 11.25 volts DC and operate in this condition for 120 hours;

c. At the end of a 15-minute shut-down period, energize the flashers and operate at 12.4 volts DC for 120 hours; and

d. From the 120th to the 132nd hour and the 240th to the 252nd hour of the test, the ambient illumination in the test chamber shall be raised to 100 foot-candles to insure that all flashers are turned off by their daylight controls.

Accelerated Life Test number 2 shall consist of operating the "F" circuit of the flasher at 70 ± 5°F. The four flashers shall be operated with the "S" and "L" terminals open, a 15 ohm, 250 millihenry load, such as the solenoid coil in a conforming CG-6P lampchanger (GFP), connected between the "F" and "-" terminals, and 12.0 volts DC input to the "+" and "-" terminals. Voltage pulses between the "F" and "-" terminals shall be monitored with a voltmeter or pulse counter so that resistive-inductive load is energized 50 times.

4.4.2.1 Acceptance/Rejection Criteria. There are no pass/fail criteria for the Accelerated Life Tests. Operation in the Electrical First Article Tests serves to verify flasher performance.

4.4.3 Electrical Tests. All ten flashers will be subjected to a series of Electrical Tests to verify their ability to function within specification at several temperatures with various loads and power source combinations. To simulate a primary battery, use a regulated, transformer-rectified DC power supply. This power supply shall be regulated such that the closed circuit input voltage to a non-fixed mode flasher, when operating a 110 watt lamp, remains within 0.1 Volts of the no-load power supply voltage. It is recommended that the power supply be rated at more than 40 Amp, with an external capacitor bank of at least 68,000 microfarads connected across the output leads, be used to meet this requirement. Test the flashers using the following combinations:

COMBINATION	CLOSED CIRCUIT INPUT VOLTAGE	LAMP LOAD
I	16.0 Vdc	110 watts
II	12.4	110 watts
III	11.25	110 watts
IV	12.4	0.55 A

To test the flasher's capability to operate with secondary batteries, use a 75-100 ampere-hour lead-acid storage battery in the following combination:

COMBINATION	LAMP LOAD
V	110 watts

Unless otherwise specified each Electrical Test will be conducted under the following conditions: at two temperature levels [-25°F(±5°F) and 140°F(-0°F, +5°F)]; five power source and load combinations; the "S" terminals open; a 15 ohm resistor between the "F" and the "-" terminals.

4.4.3.1 Voltage Regulation. For all conditions, verify that the difference between the input voltage and the output voltage at the "L" and "-" terminal complies with the requirements of 3.7.2. There are 100 data points, given 10 flashers, 5 voltage/lamp combinations, and 2 temperatures.

4.4.3.2 Timing Tolerance. For all conditions verify that the flash length, eclipse length, duty cycle and period complies with the requirements of 3.7.7.2.

4.4.3.3 Power Consumption. For all conditions, verify that the flasher complies with the power consumption requirements of 3.7.4 by completing the following measurements:

a. With a 1,000 ohm resistor across the "S" terminals, measure the input current to the "idling" flashers.

b. With the "S" terminals open, measure the parasitic current drawn by the flasher, exclusive of lamp load, with a lamp energized. Measure the parasitic current with the lamp off, inclusive of the lamp load.

It is recommended that the circuit shown in Figure 3 be used to make these measurements. There are 200 data points, given 10 flashers, 5 voltage/lamp combinations, 2 temperatures and 2 "S" terminal states.

4.4.3.4 Compatibility With Incandescent Lamps. With power and lamp combinations IV and V, verify that the flashers comply with the voltage rise and the voltage decay times required in 3.7.9. There are 20 data points, given 10 flashers, 1 voltage/lamp combination and 2 temperatures.

4.4.3.5 Lamp-out Sensor and Control. All Lamp-out Sensor and Control Tests are to be conducted with a 15 ohm resistive 250 millihenry inductive load, such as the CG-6P lampchanger's solenoid coil, connected across the "F" and "-" terminals as follows:

a. "F" Signal On. Unless otherwise specified, for each flasher and for input voltages of 18.0, and 10.0 volts DC supplied by a power supply with the "S" terminals open:

1. Verify that the "F" circuit is not activated with a 0.55 ampere lamp or a 56 ohm resistor as the "L" load.

2. Verify that the "F" circuit is activated with an open circuit as the "L" load.

3. Verify that the "F" circuit voltage pulse is between 8.0 and 18.0 volts DC, 0.25 to 5.0 seconds in length and at least one pulse every ten seconds.

b. No "Daytime" Functioning of Lamp-out Sensor and Control. For input voltages of 10.0 and 18.0 volts, a 1,000 ohm resistor across "S" terminals, and an open-circuit between the "L" and "-" terminals, verify that less than 0.5 volts DC exists across the above "F" circuit load.

4.4.3.6 Illumination Control. Illumination Control Tests will be conducted at two temperature levels [-25°F(±5°F) and 140°F(-0°F, +5°F)] and power source and lamp combinations I and III.

a. "Turn-on" and "Turn-off" Resistance. With a variable resistor connected across the "S" terminals, gradually increase the resistance from 5,000 ohms, stopping at and noting the value at which the lamp begins flashing on rhythm. Gradually reduce the resistance from that value, stopping at and noting the value at which the lamp stops flashing altogether. The resistances shall comply with requirement of 3.8.1.

b. "Turn-on" and "Turn-off" Voltage. Using the solar regulator circuit in Figure 2, gradually reduce the voltage from 12 volts, stopping at and noting the value at which the lamp begins flashing on rhythm. Gradually increase the voltage for that value, stopping at and noting the value at which the lamps stops flashing altogether. The flasher shall comply with the requirements of 3.8.2.

c. Bias-Voltage. Measure the biasing voltage across a 1,000 ohm resistor (daytime operation) and a 100,000 ohm resistor (nighttime operation) and verify compliance with the requirements of 3.8.1.

d. Spurious Operation. With the ambient illumination slightly below the "turn-on" level, and the lamp aimed directly at a type "L" photoresistor conforming to G-SEC Specification 234 from a distance of approximately six (6) inches, verify that the additional illumination from the lamp does not cause the flasher to operate on a different rhythm (3.8.3).

4.4.3.7 Acceptance/Rejection Criteria. Failure of more than one flasher to comply with all aspects of the Timing Tolerance (4.4.3.2), Lamp-out Sensor and Control (4.4.3.5) and Illumination Control (4.4.3.6) tests shall constitute a failure of the whole test procedure and shall be reason for rejecting the flashers. Acceptance/rejection of the Voltage Regulation (4.4.3.1), Power Consumption (4.4.3.3), and Compatibility with Incandescent Lamps (4.4.3.4) portion of the electrical tests shall be evaluated in terms of the 320 data points. One flasher at one power source and load test condition, temperature and evaluated against one requirement is defined as one data point. Failure of more than 8 test points from 9 flashers or identical failures from more than 3 flashers (one condition, temperature and requirement) shall constitute failure of the tests and shall be reason for rejecting the manufacturer's product.

4.5 Corrosion Resistance. Four flashers, randomly chosen from the ten FAT models, shall be subjected to the following test:

4.5.1 Salt Spray (Corrosion). Flashers shall be tested in accordance with MIL-STD-202, using Method 101, in a 5% salt solution with a 48-hour exposure time (Test Condition B). After exposure, exteriors of flashers shall be thoroughly inspected for evidence of susceptibility to corrosion.

4.5.2 Acceptance/Rejection Criteria. Any signs of corrosion or failure of the terminal markings (nameplate) to remain attached to the case on more than one flasher shall constitute failure of the whole test procedure and shall be reason for rejecting the flashers.

4.6 Production Inspections. The inspections required in this paragraph are not intended to supplant any controls, examinations, inspection, or tests normally employed by the contractor to assure the quality of this product. Each inspection lot shall be inspected for workmanship (3.6), nameplate (3.9), rhythm marking (3.10) and subjected to the Basic Capabilities Tests (4.3), with the exception of 4.3.3. Prior to performing any production inspection or Basic Capabilities Tests (4.3), each flasher in the production inspection sample shall be powered by a 14-VDC closed circuit input voltage when connected to an operating 110 watt, 12-VDC, marine signal lamp for at least one hour in an ambient temperature of 140°F (-0°F, +5°F). The contractor shall have the capability to complete this conditioning on inspection sample sizes of 50 or fewer flashers in 24 hours or less.

4.6.1 Contractor's Calibration System. The contractor shall maintain a calibration and maintenance system to control the accuracy of measurement and test equipment used in the fulfillment of this specification. The system shall include, as a minimum, prescribed calibration intervals and the source of calibration. A monitoring system to this requirement shall be readily available to the Coast Guard Inspector. Calibration shall be traceable to the National Institute of Standards and Technology.

4.6.2 Inspection Lot. A lot shall be all of the flashers of any rhythm from an identifiable production period from one manufacturer and one plant and submitted for acceptance at one time. The Contracting Officer's Technical Representative may determine that rhythm is not a distinguishing feature of flashers offered for delivery, when selecting sample size.

4.6.3 Sampling. The inspection sample size shall be as follows:

Inspection Lot Size	Sample Lot Size		Inspection Lot Size	Sample Lot Size
16 to 50	3		501 to 3,200	13
51 to 150	5		3,201 to 35,000	20
151 to 500	8			

4.6.4 Acceptance/Rejection Criteria. The lot or batch shall be considered acceptable only if no nonconforming units are found upon inspection of the random sample of the size listed in 4.6.3.

4.6.5 Failure Responsibility. If a flasher lot fails to pass production inspection, the contractor shall take corrective action on the materials or process, or both as warranted, on all items or portions thereof which were similarly manufactured and which are subject to the same cause for failure. Depending on the type and number of failures, the inspection may be discontinued at the discretion of the Government inspector until all corrective action has been taken. After all corrective action has been taken; the inspection shall be continued or repeated, depending on the reason for which the inspection was interrupted. Acceptance shall be withheld until re-inspection has shown that the corrective action was successful and the equipment or portion thereof satisfactorily passes all inspections.

4.6.6 Resubmitted Lots. If an inspection lot is rejected, the manufacturer may rework the lot or screen out defectives and resubmit it for inspection. Resubmitted lots shall be kept separate from new lots.

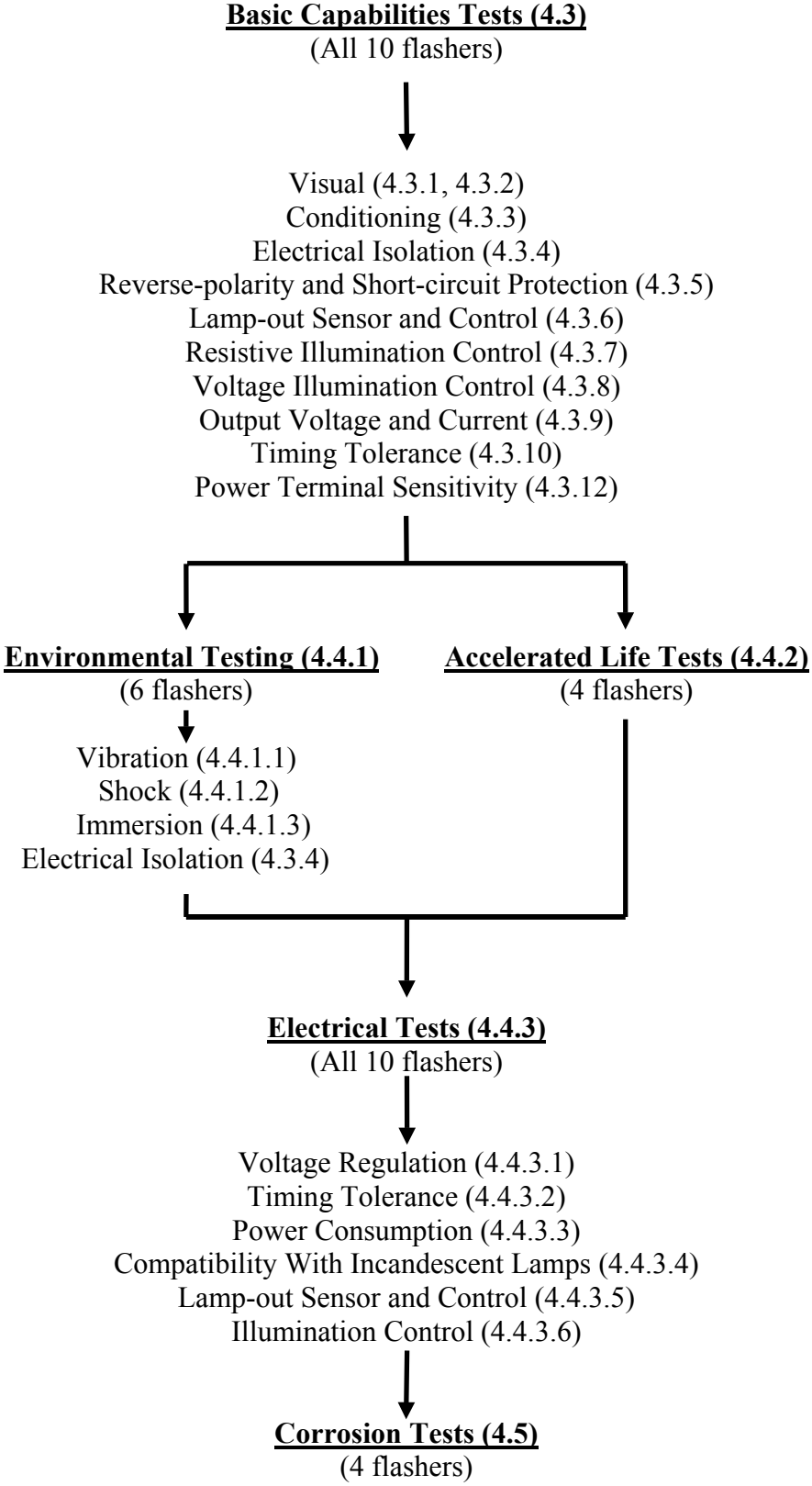
5. PREPARATION FOR DELIVERY.

5.1 Packaging. Preservation and packaging shall conform to the requirements of ASTM D 3951, standard commercial practice.

5.2 Packing. The flashers shall be packed in accordance with the requirements of ASTM D 3951, standard commercial practice.

5.3 Marking. Interior and exterior containers shall be marked in accordance with MIL-STD-129. Bar codes are required in accordance with ANSI/AIM BC 1. Precautions necessary for full protection of the flashers shall be prominently located as specified in MIL-STD-129.

TABLE I
DETAILED TESTING REQUIREMENTS



SOLAR TEST CIRCUIT

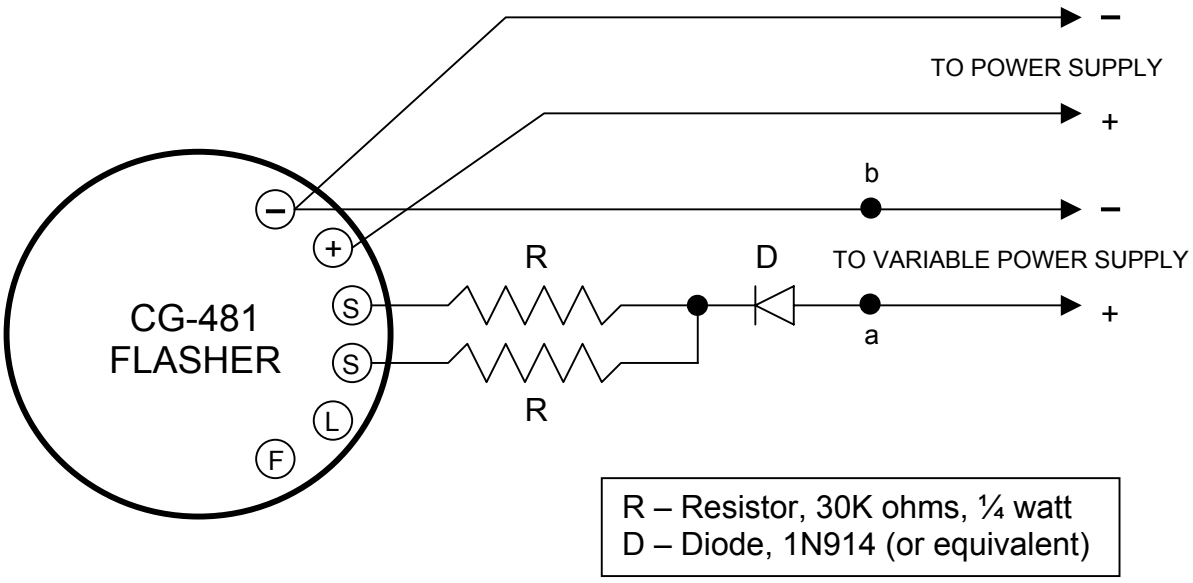
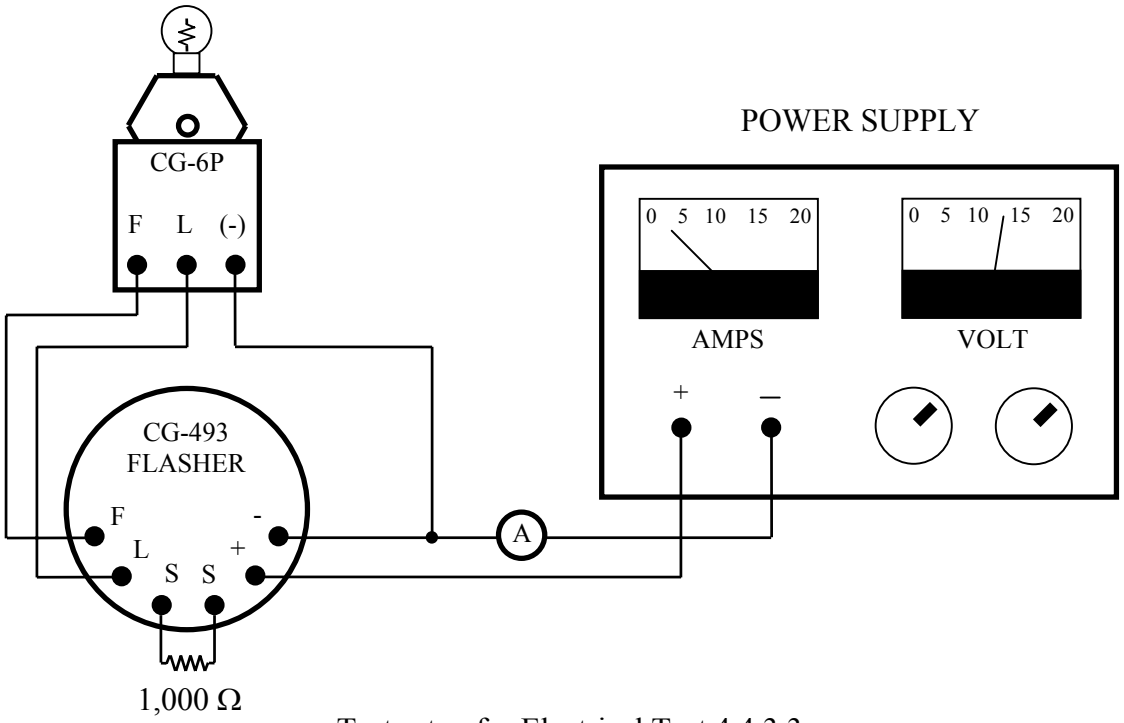
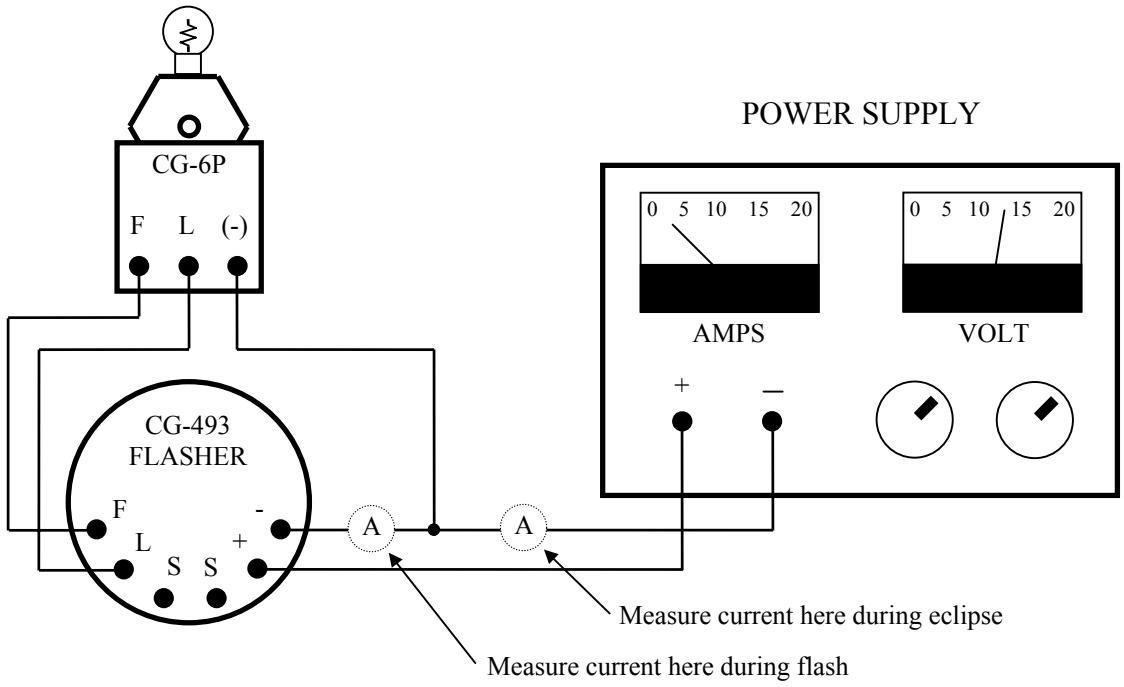


Figure 2

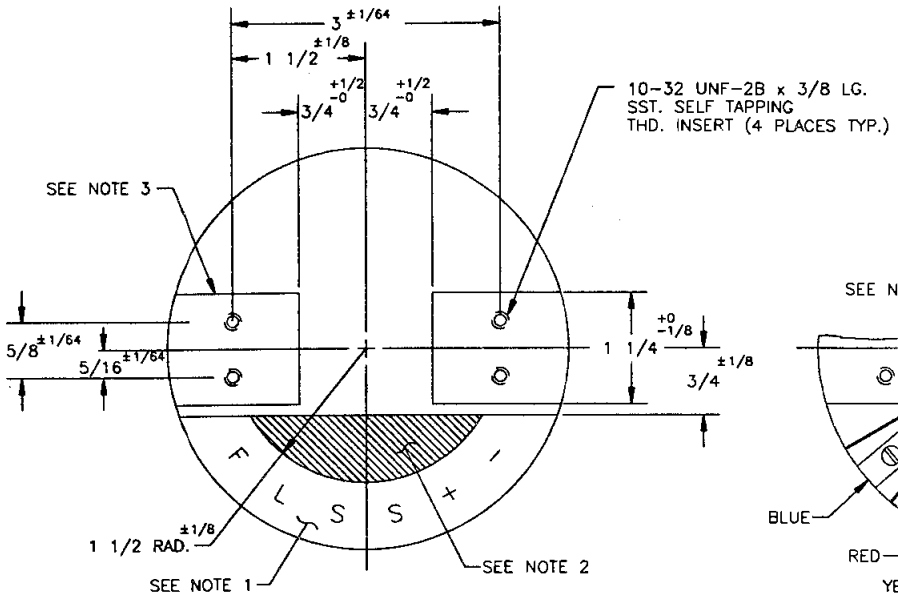


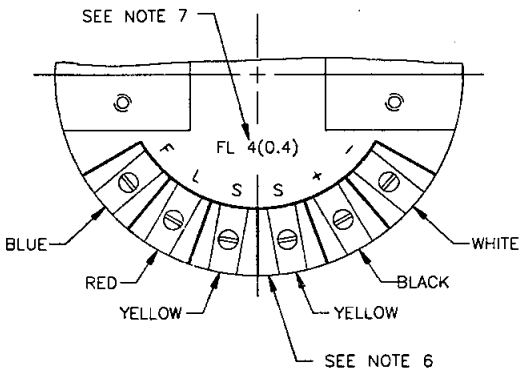
Test setup for Electrical Test 4.4.3.3.a

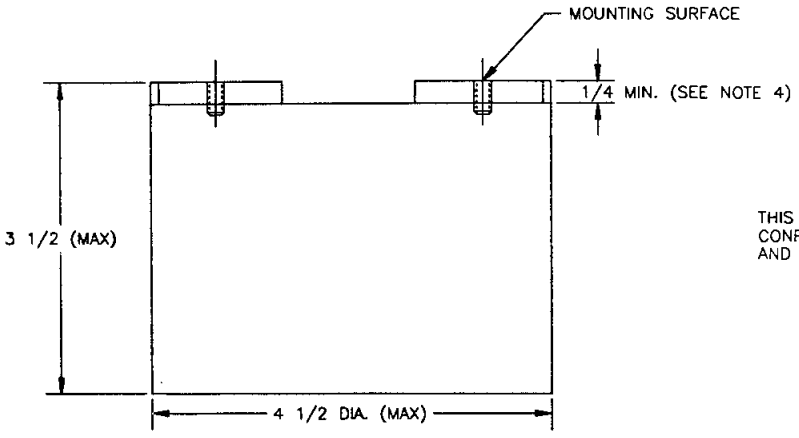


Test setup for Electrical Test 4.4.3.3.b

Figure 3







THIS DRAWING SHOWS DIMENSIONS OF FLASHER, CONFIGURATION OF TERMINALS, BOLT HOLES AND PLACEMENT OF MARKINGS.

NOTES:

1. LOCATION, IDENTIFICATION AND ORDER OF TERMINALS AND TERMINAL INSULATORS.
2. LOCATION OF RHYTHM AND TERMINAL MARKINGS.
3. MAXIMUM SIZE OF MOUNTING SURFACE.
4. MINIMUM HEIGHT OF MOUNTING SURFACE ABOVE REMAINDER OF CASE.
5. MATERIAL TO MEET REQUIREMENTS OF SPECIFICATIONS.
6. EXAMPLE OF CORRECTLY LOCATED TERMINALS AND MARKINGS.
7. RHYTHM AND TERMINAL MARKINGS MAY BE INCORPORATED IN THE NAMEPLATE.

REV.	DATE	APPR.	DESCRIPTION	BY
E	4-26-93		REDRAWN USING AUTOCAD. ADDED TOLERANCES.	S.M.
D	3-8-85		CHANGED NOTES	JTG
C	6-16-67		REDRAWN WITH CHANGES.	RAS

DESIGNED: W.W.W.
DRAWN: RAS
TRACED: S.M.
CHECKED: M.J.B.
REVIEWED BY: KRS
CHIEF
REVIEWED BY: JEW
CHIEF, OE BRANCH
REVIEWED BY:

U.S. COAST GUARD HEADQUARTERS

CIVIL ENGINEERING

12-VOLT SOLID-STATE FLASHER

APPROVED: J. Norman
CHIEF OF DIVISION
DATE 6-17-67

UNLESS OTHERWISE SPECIFIED:
ALL DIMENSIONS ARE IN INCHES.
TOLERANCES: DIM. AS NOTED
ANG. ±30'

DRAWING NUMBER 120006 REV. E

SCALE: FULL SHEET 1 OF 1

SPECIFICATION FOR 12-VOLT, 110 WATT
SOLID STATE FLASHER FOR MARITIME AIDS
TO NAVIGATION

SPECIFICATION NO. 481A

JUNE 2004

Prepared by:

/s/

K. AGI
Project Engineer

Reviewed by:

/s/

J. T. GRASSON
Team Leader,
Signal & Power Team

Approved by:

/s/

H. R. CLEVELAND
Chief, Ocean Engineering Division

21 JUN 2004

Date